

CSC T8 (Single Top) Status Report

Simona Rolli -Tufts

(Arnaud Lucotte -LPSC)

(Akira Shibata -NYU)

Activities from last time

- Last status report at top meeting was on Oct 10:

Many progress in in all three channels

– t-channel : should be ready CutBased + TMVA in time (Nathan+Akira)

A lot of strong involvements in systematic uncertainties:

– PDF and b-fragmentation: 1st results already (Gia, Markus, Doug)

– ISR/FSR: strategy for MC production should be ready soon (Jim,Kyoko)

Pile-up samples:

Ready to re-run the analyses on pile-up MC fullSim samples

Note writing in progress !

- Three more T8 meetings since then:

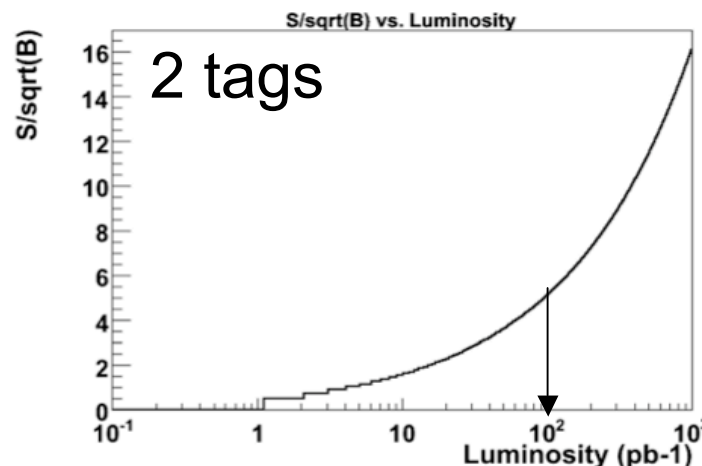
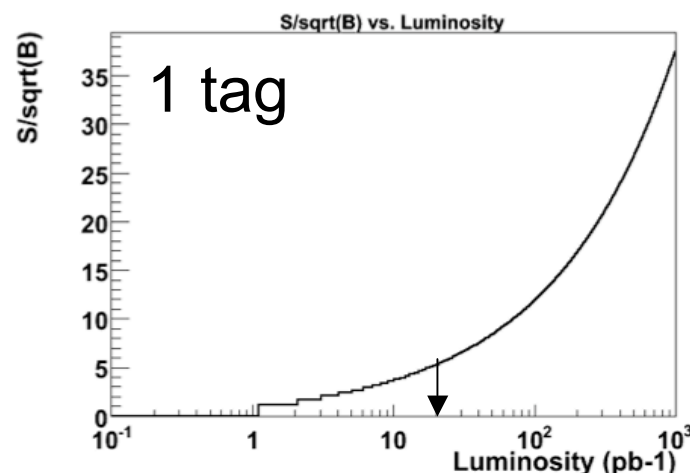
- ♦ Strategy with early data
- ♦ ISR/FSR systematics progress
- ♦ PDF uncertainties progress
- ♦ Common preselection comparisons
- ♦ Revised guidelines for physics objects (muons, electron isol, etc)

Deadline pushed to end 2007

Significance studies of early data

Jenny Holzbauer (MSU)

- **Sigma vs. Luminosity**

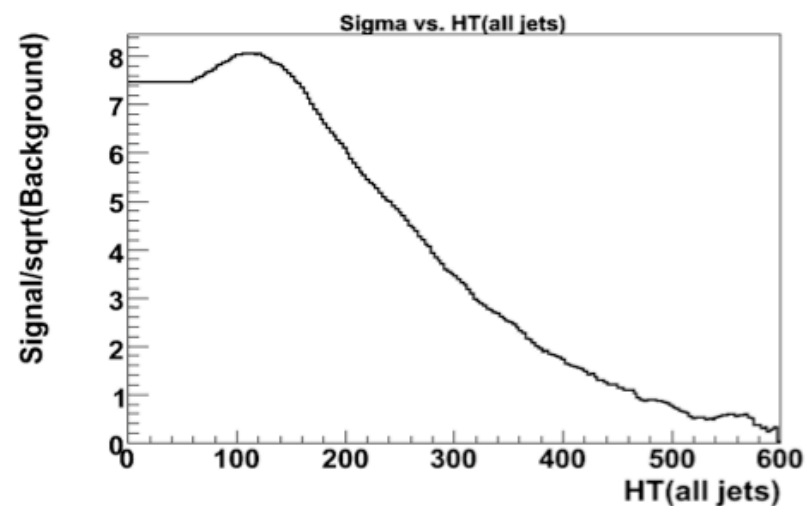
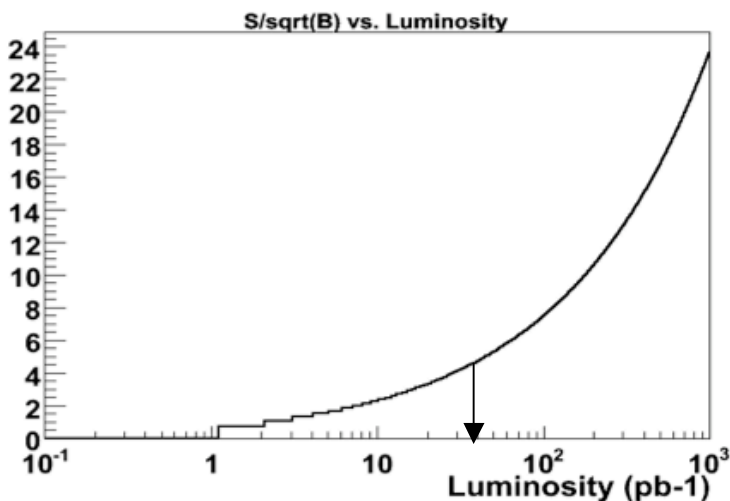


- **Optimizing Sigma for additional variables**

- Looked at several additional variables including different Ht's, H's, deltaPt's, DeltaR's, Pt's, Eta's, W Mt, Top M, MET, jetN, max and min jet eta, centrality (sumPt/sumP)
- After looking at all of the variables, none of them showed any particularly large increases in S/sqrt(B), should a cut be made

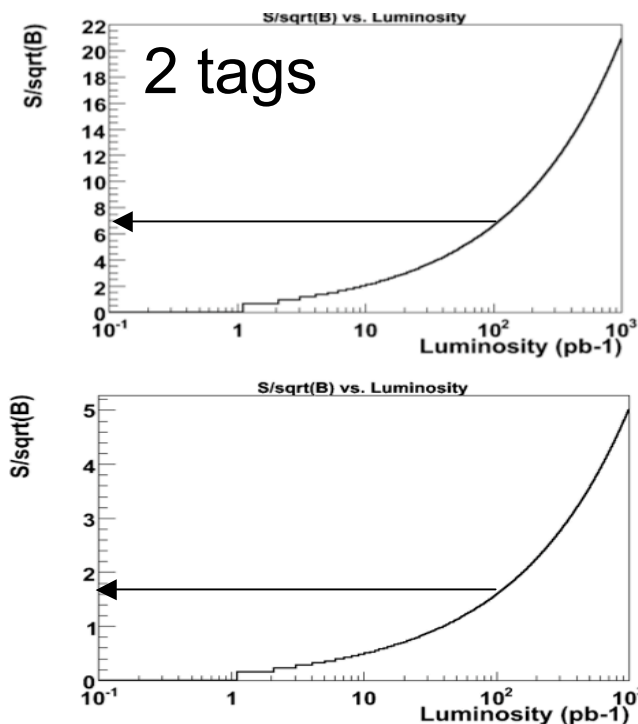
Significance studies with early data (cont'd)

- **Sigma with no b-tagging**
 - B-tagging information may not be good for early data, so a run was done without any preselection cuts related to b-tagged events
 - At 100pb⁻¹, sigma is 7.5, 5 sigma level is at 45 pb⁻¹
 - Cut indicated to keeping events with Ht(all jets) > 109 GeV (lower right plot), which raised sigma to 8.1 at 100pb⁻¹, and resulted in reaching 5 sigma at about 40pb⁻¹



Effects of systematics on early data reach

- **Study jet energy calibration uncertainty:**
 - Assume 10 percent error on relative jet energy between data and MC
 - Shift jet energy up and down by 10%
 - following procedure in one of Arnaud's talks
 - Recompute total background after this shift
 - Find change in background yield due to shift
 - Recalculate signal significance:
instead of S/\sqrt{B} , calculate $S/\sqrt{B + \sigma_{JES}^2}$



- The JES systematic has a relatively large impact on the sigma value
- The S/\sqrt{B} numbers without systematics indicate it may be possible to have a discovery in early data, but more work will have to be done to reduce the effects of the systematics to make this possible

PDF Uncertainty

Gia Khoriauli & Marcus Cristinziani (Bonn)

The main goal is to study how the PDF uncertainty propagates to the single top final state selection efficiency uncertainty.

Receipe as given in hep-ph/0303085 :

For a given observable, take : $\Delta O = \frac{1}{2} \sqrt{\sum_{i=1,nPDF} (O_{i+} - O_{i-})^2}$ (1)

→ i=1,40 for CTQ6M set

→ i=1,30 for MRST2002 set

PDF Uncertainty

$$\Delta \epsilon = 1/2 * \sqrt{\sum (\epsilon_i^{max} - \epsilon_i^{min})^2} \quad i=1, \dots, 20 \quad (1)$$

★ PDF parameter variation not always varies the observable value in opposite directions wrt the central value. Both can simultaneously vary to higher or lower values.

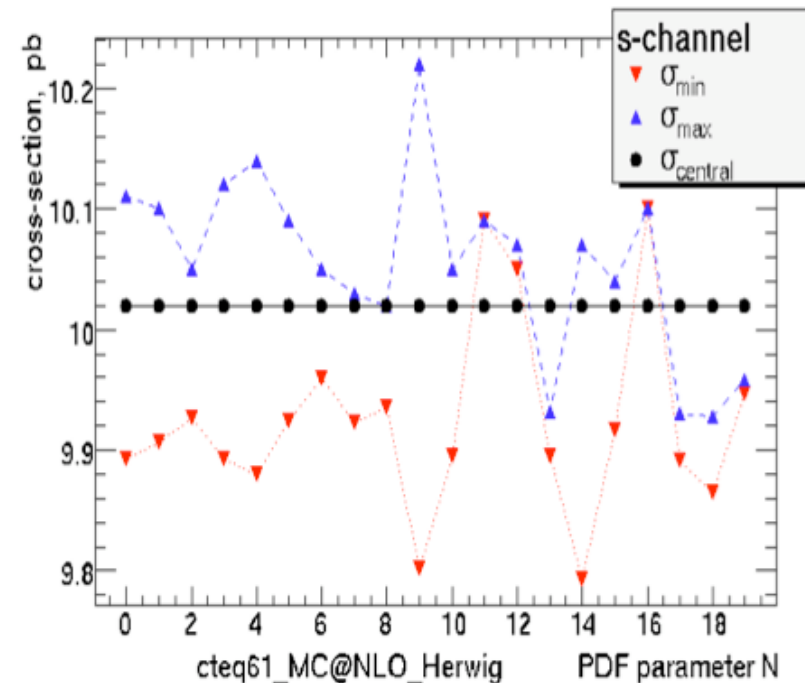
★ The plot of cross-section dependence on the PDF error set clearly shows this.

★ Then to still have valid Hessian approach instead of formula #1 one needs to use two similar formulas for the plus and minus uncertainties

$$\Delta \epsilon^+ = \sqrt{\sum (\epsilon_i^{max} - \epsilon_i^0)^2} \quad i=1, \dots, 20 \quad (2) \quad (1)$$

$$\Delta \epsilon^- = \sqrt{\sum (\epsilon_i^0 - \epsilon_i^{min})^2} \quad i=1, \dots, 20 \quad (3) \quad (2)$$

★ We use these formulas to calculate uncertainties on the selection efficiencies



PDF Uncertainty (cont'd)

PDF Re-weighting Method

★ Our study of PDF uncertainty propagation on single top selection efficiency uncertainties showed that the direct calculation of them requires enormously large statistics in order to beat statistical fluctuations

★ We started to adopt a PDF re-weighting method (also used at D0)

★ The idea is a linear propagation of events weights due to PDF uncertainties to the uncertainty of a measured quantity

★ This means that each event will have assigned a set of N (N - number of PDF error set member PDFs) weights:

$$\frac{f_i(x1, Q) * f_i(x2, Q)}{f_0(x1, Q) * f_0(x2, Q)} \quad i=1, \dots, N$$

★ Where, f_0 and f_i are PDF values evaluated at Central Value and i -th member PDFs for the interacted initial partons

★ Then, for example, the final uncertainty of a selection efficiency will be calculated using the same #1 and #2 formulas. But instead of selection efficiency values the normalized weight sums for the selected events will be used

PDF Uncertainty (cont'd)

PDF Re-weighting Tool – Implementation Requirements/Details

★ The crucial issue for the re-weighting tool functionality is an access on the following information of the MC event, which should be provided by MC Generators

- The flavors of interacted initial partons - $f1, f2$
- Their momentum fractions – $x1, x2$
- Transferred momentum - Q
- PDF values evaluated at the event generation – $pdf1, pdf2$

Much discussion in the MC generator group (Dec 10 meeting)
A private version of the code is available

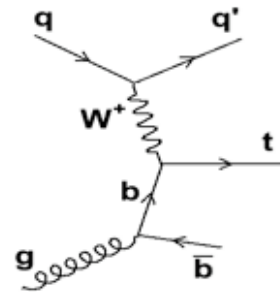
★ At this time we can validate the tool only for processes in *s-channel*. The main problem for processes in *t-channel* is a calculation of transferred momenta – Q

Validation of re-weighting method

★ CTEQ6.1 NLO PDF error set , 41 PDFs

★ MC@NLO (v3.3) + HERWIG, 13.0.30 (Generation & Atfast)

→ t-channel, **W** decays in **enu**, **munu** & **taunu** mode
 $3 * 41 * 100K = 12.3M$ events



★ To validate the re-weighting method we still need direct measurements with large statistics

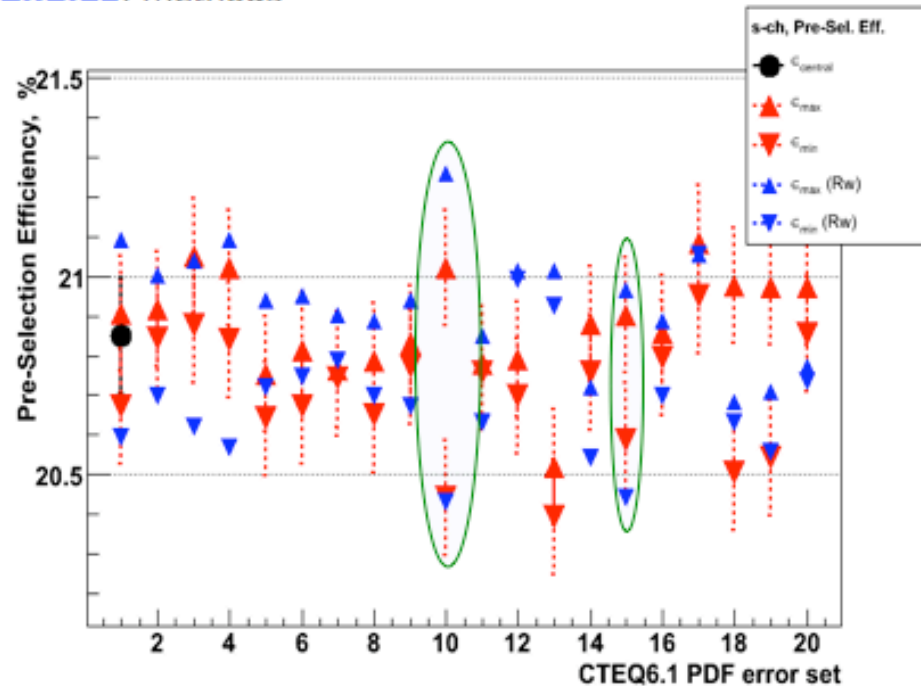
★ Validation can be done at Pre-selection level since the statistics is still larger than it is at final selection level

Validation of re-weighting method

★ The plot shows the results of s-channel Pre-selection efficiencies obtained from using direct (**red triangles**) and re-weighting (**blue triangles**) methods

★ Statistical fluctuation in direct measurement is still considerable but it seems we can recover the largest variations of PDF uncertainties when comparing to the re-weighting method

★ The marked (ellipse) points shows this



PDF Uncertainty preliminary results

Generator/Channel/Final State	Selection Efficiency at PDF Central Value, %	Uncertainties due to PDFs		Re-weighting	Method
		abs. syst. uncert. (+), %	abs. syst. uncert. (-), %	rel. syst. uncert. (+), % %	rel. syst. uncert. (-), % %
MC@NLO / s-ch. / enu	3.24 +- 0.06	0.1	0.19	3.05	5.96
MC@NLO / s-ch. / munu	3.58 +- 0.07	0.13	0.19	3.63	5.31
MC@NLO / s-ch. / tau->enu	0.35 +- 0.04	0.01	0.02 6	2.86	7.43
MC@NLO / s-ch. / tau->munu	0.47 +- 0.04	0.01 5	0.03	3.19	6.89
MC@NLO / t-ch. / enu	5.62 +- 0.10				
MC@NLO / t-ch. / munu	6.44 +- 0.11				
MC@NLO / t-ch. / tau->enu	0.60 +- 0.06				
MC@NLO / t-ch. / tau->munu	0.90 +- 0.07				

In progress

PDF Uncertainty (cont'd)

Similar work carried on by **Doug Schouten (SFU)**

- ▶ I have written an algorithm/tool that interfaces with external generators and runs at the parton showering stage
(`/afs/cern.ch/user/s/schouten/public/PDFAnalysis`), can store the weights in the AtIFAST ntuple
- ▶ first jobs still running with my PDF reweighting tool ... results very soon
- ▶ unclear how systematic $\Delta\epsilon$ in AtIFAST translates to full Monte Carlo
- ▶ impossible to do the brute force method on full MC anyway because of inordinate computing requirements
- ▶ therefore, upcoming work plan is
 - ① validate PDF reweighting tool with one very high statistics control sample in AtIFAST
 - ② use the PDF reweighting method to derive a systematic uncertainty in the full MC

ISR/FSR Radiation Uncertainty

Goal: to study the change in efficiency selection due to changes in the MC generator switches regulating ISR/FSR

So far: generator-level studies to determine which settings to combine to produce ATLFAST samples

* 4 variation sets/samples of cuts differing only in the number of jets required were used;

• Several problem with generating the samples, probably due to incorrect use the of multiple interactions master switch

Next Steps:

J.Cochran
K.Yamanaka

- Efficiency studies for MI Off samples using Arnaud's/Akira's cuts (generator level and ATLFAST level [when available])
- Study correlations among Pythia parameters (with & without MI)
- Include b-tagged jets in generator level efficiency studies
- Generator level W_t efficiency studies (to select ISR/FSR variation parameters)
- Send W_t samples through ATLFAST with pathena
- Outline & start writing note on ISR/FSR in single top

Preselection Cuts Comparisons

Several subtle differences in the number of events selected by different groups following the same recipe.
(ambiguity in the content of TopView and cut definition)

Investigation under way and convergence on the cuts.

Status of the CSC note

- The physics coordinator requested consistent use of object selection across CSC analysis.
- We are affected too.
- Most of the recommended selection cuts are now defined and under test,
 - We now must use Staco muons (robust performance under cavern background and pile up). No chi2 cut applied.
 - Electron selection changes slightly (from isEM mask 0x7FF to 0x3FF)
 - Use of electron isolation is discouraged (buggy...)
 - Early analysis should use IP2D b-tag algorithm.

Status of the CSC note (cont'd)

Deadline for a complete draft officially delayed : ~ end of the year

Appointed referees :

→ Yann Coadou (external) and Marina Cobal (Top WG internal)

Our goal :

Prepare for re-running our selections on new TopView ntuples ASAP:

→ Re-assess numbers for recoPerf, event yields, systematics

→ Use new MC production : extended W+jets sample

Having completed all analyses & systematics by mid-December

→ All long-term analysis (Cut Based + MVA) completed

→ Re-assess systematics due to b-tag/TRF tag & b JES

→ Re-assess systematics due to PDF & ISR/FSR, b-fragmentation

Having shown consistency : cross-checks on pre-selection & full selection

→ Preselection numbers to be checked : Akira + Patrick + Jenny + Arnaud

→ FullSelection numbers to be checked :

Gia, Markus, Doug, working on PDF estimates, Jim, Kyoko on ISR/FSR
with Benoit, Akira and Arnaud

Status of the CSC note (cont'd)

I. Introduction

1. Introduction (Reinhard)

→ OK

2. Phenomenology (Reinhard, Simona, Arnaud)

Description basically written

Cross-section tables to update → Simona, Arnaud

Description of MC used to update → Simona

3. RecoPerf & Trigger (Akira, Mohsen, Claudiu, Patrick)

RecoPerf (FullSim and FastSim) to be re-assessed with new production

– Muon Staco (no big change expected)

– Add Isolation for electron

→ Mohsen, Claudiu, Simona ?

B-tagging and TRF tagging to be presented

→ Akira ? (with reference To Akira's TRF note)

Status of the CSC note (cont'd)

II. Standard Selections (long term $> 1 \text{ fb}^{-1}$)

1. Common Preselection (Arnaud)

Cross-checks to be completed \rightarrow Akira, Patrick, Jenny & Arnaud
& Update the tables with the new production

2. t-channel Analysis (Akira, Nathan)

Cut Based Analysis : selection ~finalized, numbers with new MC \rightarrow Akira
NN Analysis : description not started, numbers with new MC
 \rightarrow Akira, Nathan

3. s-channel Analysis

Cut Based Analysis : selection OK. Tables complete. Cross-checks w/ Gia, Markus \rightarrow Arnaud, Gia
Likelihood : description OK. Tables complete. Variables Uncorrelation to be implemented \rightarrow Arnaud

4. W+t channel Analysis

Cut Based Analysis : OK Tables complete. Figures to be added \rightarrow Benoit
Likelihood Analysis : OK. Tables complete. Btag and JES Systematics under work \rightarrow Benoit

Status of the CSC note (cont'd)

II. Standard Selections (long term $> 1 \text{ fb}^{-1}$)

5. Systematic uncertainties

Since several uncertainties are estimated the same way → put in this Section

Note : will have to be re-assessed with new Production

B-tagging :

– Results for s-channel present, W_t under writing → Benoit, Akira, Arnaud

JES determination:

– Results for the s-channel present → Benoit, Akira, Arnaud

PDF & b-fragmentation:

– Effects on selection being assessed → Gia, Markus, Doug

Cross-checks needed with individual selections

→ Benoit, Arnaud, Akira for feedback

ISR/FSR:

→ Production of samples started

→ Jim, Kyoko

Status of the CSC note (cont'd)

III. Strategy with the early data ($< 1\text{fb}^{-1}$)

1. Event Selection → Bernard, Jenny, Reinhard
2. Sensitivity
3. Additional variables
4. Discovery Potential w/ 20, 100 pb^{-1}

Note : Will have to be re-run with new production

Note : the CSC note is already a 50 p. document. I think we should consider it as a maximum

.... Eventough systematics are not fully included yet (except 2 p.) !

- Phenomenology ~4 p. , RecoPerf ~4 p. and Trigger ~2 p.
 - Pre-Selection ~4 p. and individual analyses (no systematics) ~7-8 p. x 3
 - Strategy with early data (no syst) ~4 p.
- Need to a brief summary of general RecoPerf (2 p) with reference to Akira's note and to focus on single-top tools (TRF...)
- Need complete/short descriptions of selections but with reference to detailed individual notes encouraged (Benoit, Arnaud, Akira, Jenny...)

Other topics

Akira Shibata (NYU)

Single Top Cross-sections in pb

	NLO calculation		LO AcerMC (Inclusive σ)	NLO/LO ratio
t-channel	$246.6^{+9.3}_{-10.2}$	[1]	251	0.98
s-channel	$10.65^{+0.65}_{-0.64}$	[1]	7.1	1.5
Wt	66 ± 2	[2]	58.1	1.14

Top Mass = 175 GeV/c²

[1] Sullivan,Z. Phys.Rev. D70 (2004) 114012

error scale + $\Delta m_t = 2$ GeV + PDF + b mass + α_s

[2] Campbell, D70 (2004) 094012

error scale only

Need to revise

We will scale all samples to NLO theoretical calculation.

Samples cross sections

	AcerMC sample	LO AcerMC	Scaled to NLO
t-channel	5502 [1]	81.5	80.0
s-channel	5501 [1]	2.3	3.5
Wt	5500 [2]	25.5	29.0

[1] with W decaying to e, μ, τ

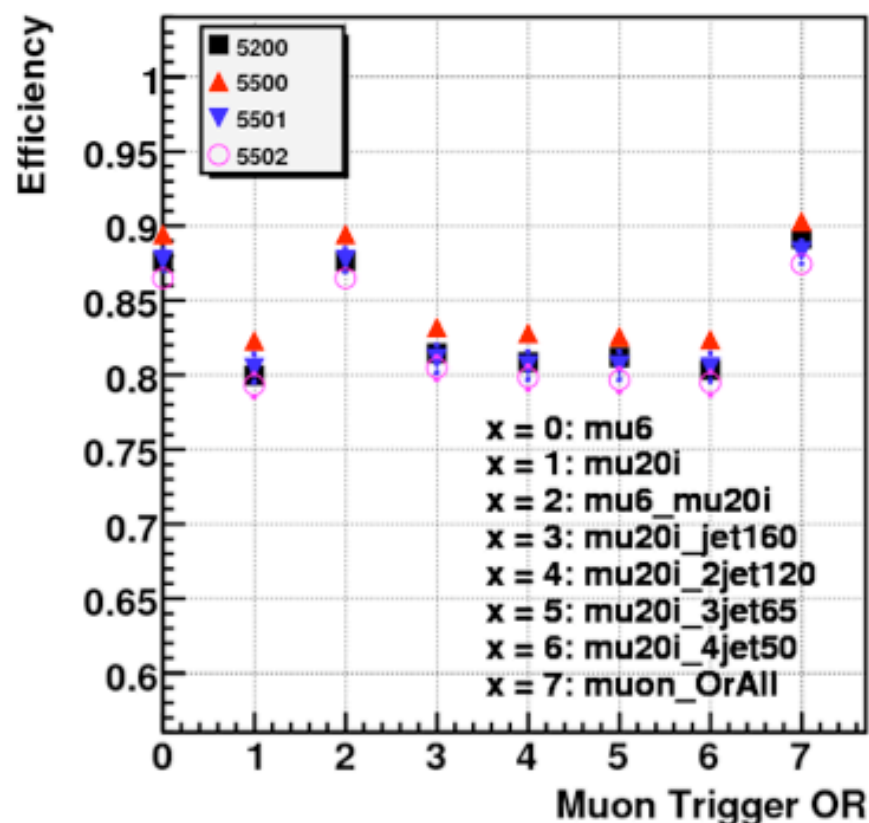
[2] with one W decaying to e, μ, τ ; other W decaying to jets
dilepton final state is not included

*cross sections in pb

Trigger Efficiencies

Patrick Ryan (MSU)

Muons



mu20i

- Currently used
- 80% efficient

mu20i OR mu6

- 87% efficient

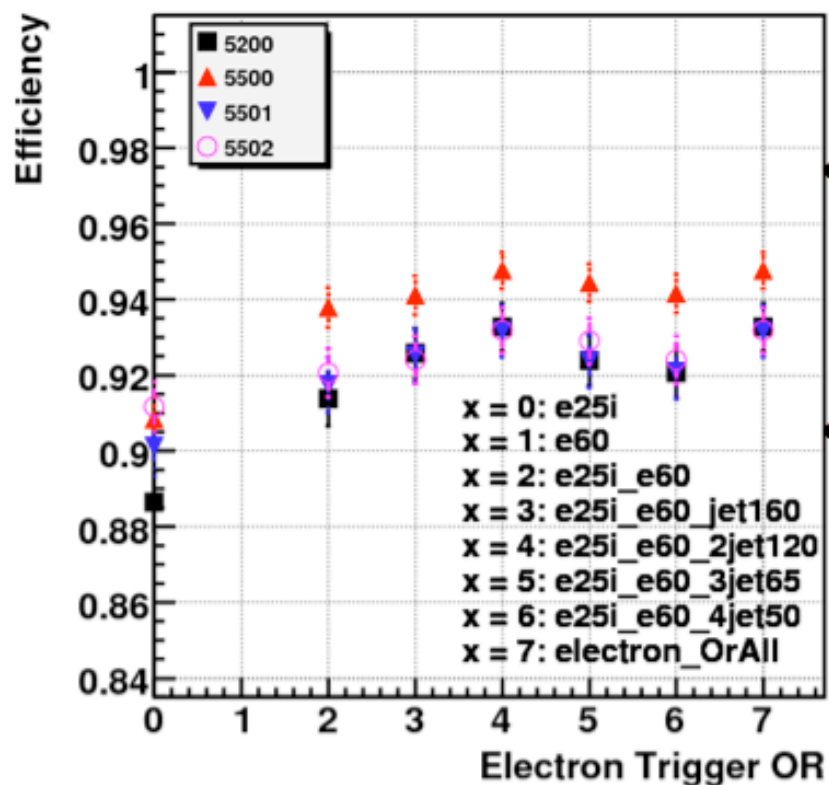
mu20i OR mu6 OR Jets

- 88% efficient
- Jet triggers don't give much efficiency increase

Should consider using mu20i OR mu6 for single top selection

Trigger Efficiencies

Electrons



- **e25i OR e60**
 - Currently used
 - ~93% efficient
- **e25i OR e60 OR 2jet120**
 - ~94% efficient
 - Other jet triggers don't increase efficiency
- **e25i OR e60 suitable for single top event selection**